Space Weather Technical Forecast

Issued on Wednesday 22 January 2025 at 13:08 Local

This technical forecast provides a four-day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

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Space Weather Forecast Headline: Isolated M-class flares likely, with a slight chance of X-class flares. Chance of Active electron fluence.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity remained at Moderate levels, with an isolated M1.3 flare at 22/1106 UTC from region AR3961, located in the southwest quadrant.

There are currently eight sunspot regions on the Earth-facing disc. AR3961, located in the southwest quadrant, continues as the largest sunspot group, with flare activity picking up again after a brief lull. The magnetic configuration of its constituent spots is moderately complex, with a Beta-Gamma classification, and some slight overall decay is evident in recent imagery. AR3959, in the northwest, is a moderate size spot but has not shown any significant change in recent hours. AR3967 in the southeast now has a very small delta configuration in one of its intermediate spots. All remaining spot groups are relatively small and have shown only small changes in recent hours.

The M1.3 flare mentioned above appears in imagery to have caused a filament eruption to the east of AR3961. Given its near centre-disc location some Earth-directed component is likely, with analysis awaiting the relevant imagery to come in.

Solar Wind / Geomagnetic Activity: Ongoing fast but easing winds from CH09/- were observed. Solar wind speed, as measured by ACE and DSCOVR saw a gradual decline from elevated to slightly elevated levels (570 km/s to 460 km/s). Density was below average. The Interplanetary Magnetic field, Bt, was Weak throughout, with the north-south component, Bz, varying between +4/-5nT. Phi angle was mainly negative (towards the Sun) overall, but showed frequent changes to positive (toward the Sun) after 21/1800UTC. The resultant geomagnetic activity was Quiet to Unsettled (Kp1-3).

Energetic Particles / Solar Radiation: High energy proton flux (greater than 10MeV) at GOES18 was at Background. High energy electron flux (greater than 2MeV) at GOES16 was mainly Moderate, peaking 882pfu at 21/1630UTC. The associated 24-hour fluence persisted below the Active threshold, reaching 3.28e7 integrated pfu at 22/0000UTC.

Four-Day Space Weather Forecast Summary

Solar Activity: Moderate activity is forecast, with isolated M-class flares likely and a slight chance of isolated X-class flares.

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Solar Wind / Geomagnetic Activity: A CME associated with the M3 flare on 21 Jan, from AR3967, has been modelled and gives a possible glance past Earth early on 25 Jan.

Solar winds are currently slightly elevated, around 470 km/s, but on a slow downward trend. This gradual reduction in wind speeds is expected to continue as the influence of the fast wind from CH09/- wanes. However, should the 21 Jan CME glance Earth on 25 Jan a temporary increase may occur.

Generally Quiet to Unsettled geomagnetic activity is expected, with a reducing chance of Active intervals through the period. However, there is a slight chance of G1/Minor Geomagnetic Storm intervals early on Day 4 (25 Jan) should any CME impacts occur.

Energetic Particles / Solar Radiation: GOES18 high energy proton flux is expected to be at Background, but with a slight chance of enhancements exceeding the S1 Minor Radiation Storm threshold should any notable flares occur. GOES16 high energy electron flux is forecast to be largely Moderate, perhaps peaking High, although the longevity of the periods of High is low confidence. The associated 24 hr fluence is expected to see a rising trend, but although there is a chance of reaching the Active threshold (1e8 integrated pfu) through Days 1 to 3 (22-24 Jan), fluence levels are probably more likely to remain below the Active threshold.

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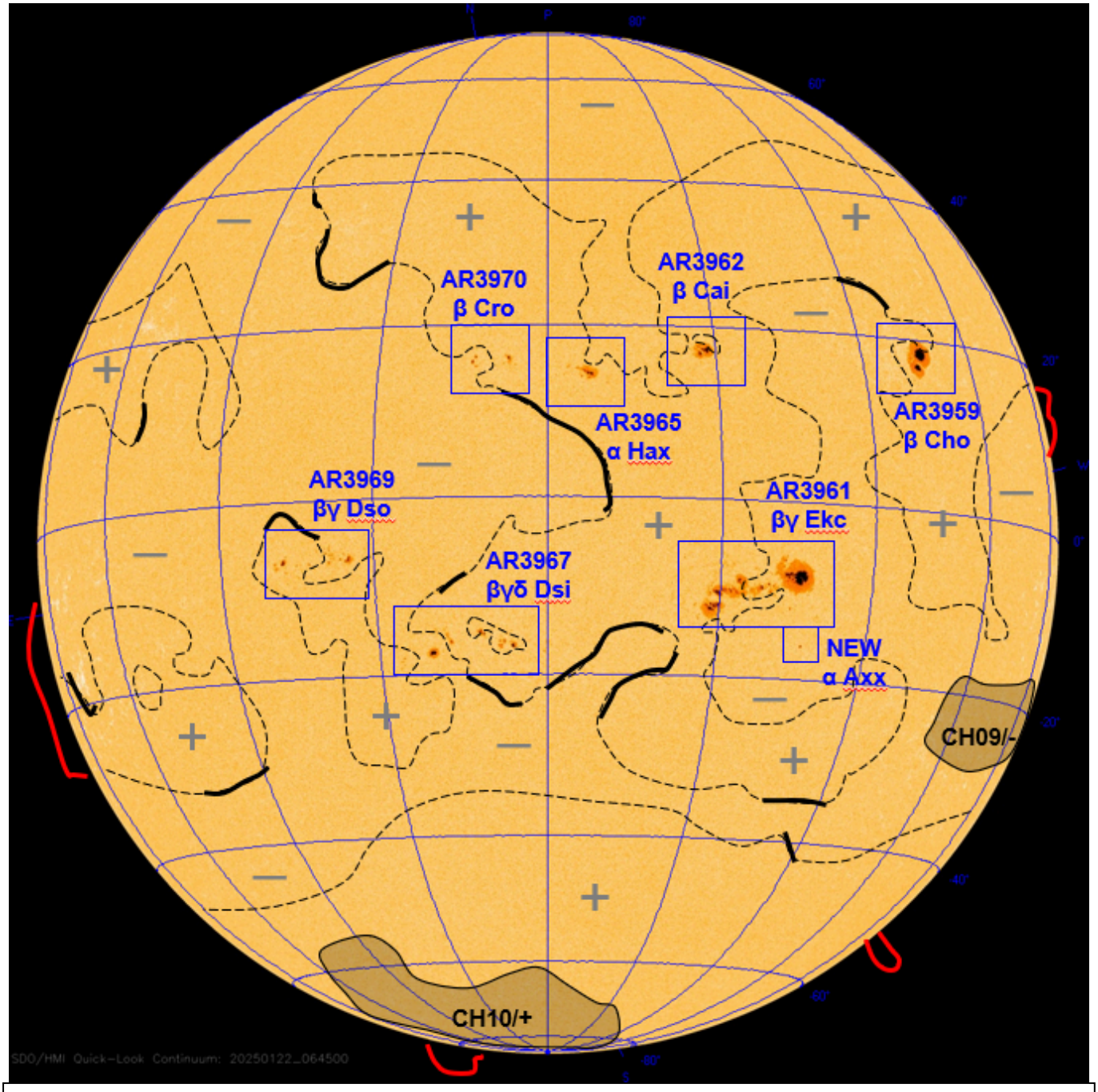
Figure 1: Solar Synoptic Map valid 22/0800 UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms

An M1.3 flare was observed from the trailing portion of AR3961, peaking at 22/1106 UTC, with a nearby filament eruption and associated dimming seen in imagery to the east of this, as well as a Type II radio emission (estimated velocity 561 km/s). Coronagraph imagery is awaited for any potential Earth-directed CME, although given its near centre-disc location this is likely. The one CME currently in the forecast is from the long duration M3 flare on 21 Jan from AR3967, modelled to give a possible glance past Earth early on 25 Jan, with a slight chance of G1/Minor Geomagnetic Storm intervals.

Solar winds are currently slightly elevated, around 470km/s, but on a slow downward trend. This gradual reduction in speeds is expected to continue as the influence of the fast wind from CH09/-wanes. This gradual decline is supported by MOSOWC ENLIL model output which is viewed as providing reasonable guidance. However, should the 21 Jan CME glance Earth on Day 4 (25 Jan) a temporary increase may occur.

Generally Quiet to Unsettled geomagnetic activity is expected, with a reducing chance of Active intervals through the period. However, there is a slight chance of G1/Minor Geomagnetic Storm intervals early on Day 4 (25 Jan) should any CME impacts occur.

Geomagnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	5	5	10	20
Strong	G3	No	1	1	5	5
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R⊙ (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed (km/s)	Estimated Arrival Time (UTC)	Comments
21/1027	Partial	AR3967	SE	537	25/0600	Possible glance.

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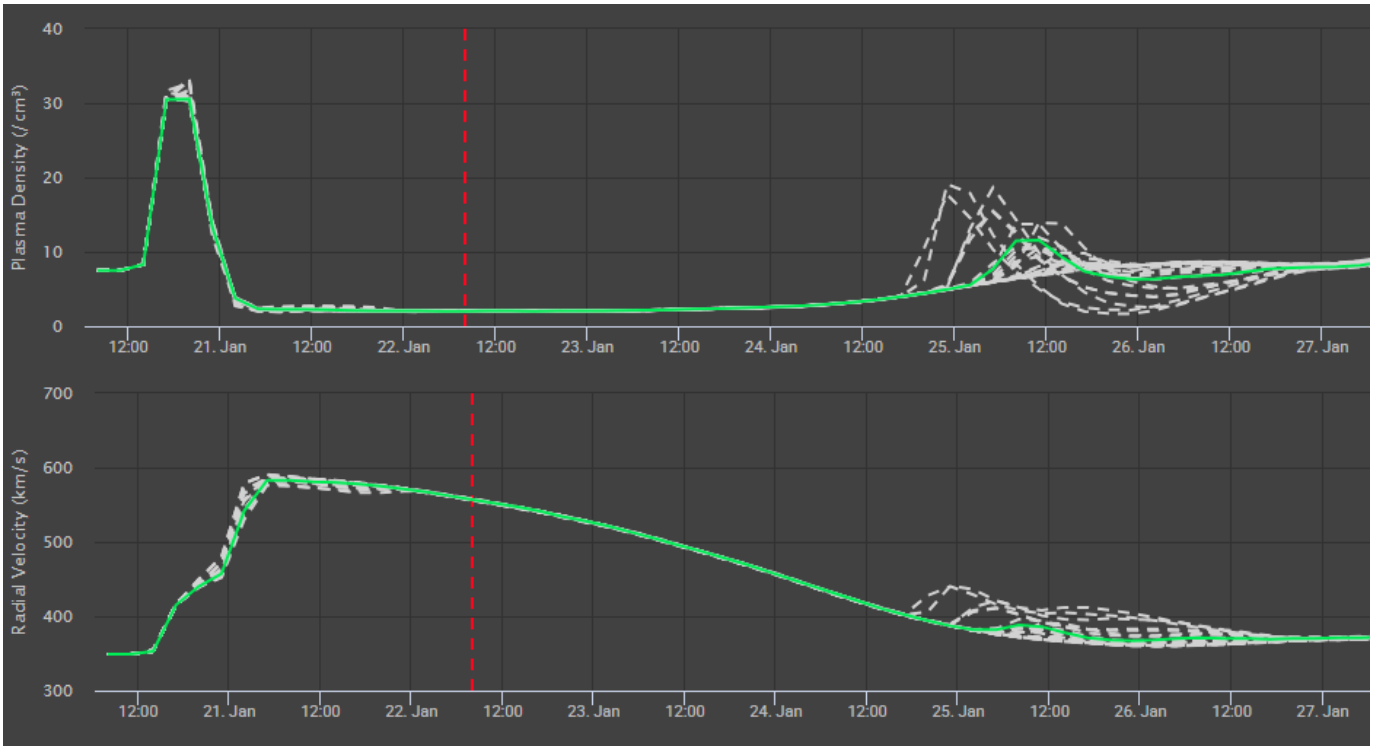
Figure 2: MOSWOC Ensemble model, showing declining fast winds, and then possible arrival of CME glance early 25 Jan.



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Radio Blackouts - X-Ray Flares

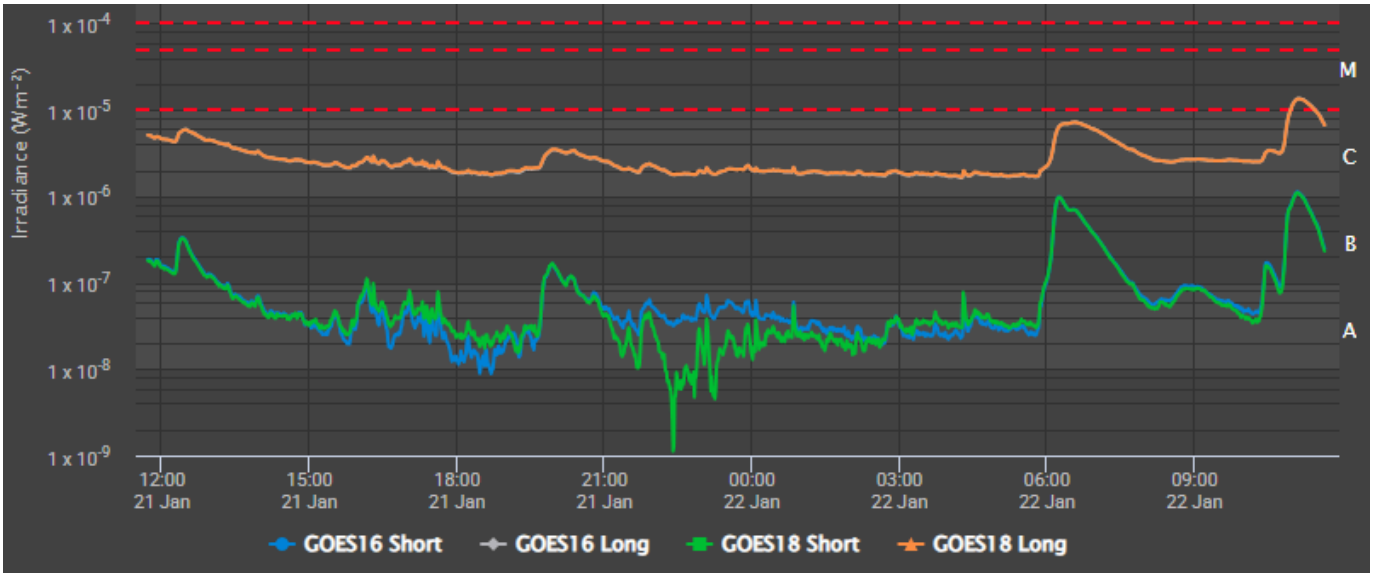
There are currently eight sunspot regions on the Earth-facing disc, following the transit of AR3964 around the west limb. AR3961, located in the southwest quadrant, continues as the largest sunspot group, yet flare activity remains largely muted. The magnetic configuration of its constituent spots is moderately complex, with a Beta-Gamma classification, and some slight overall decay is evident in recent imagery. AR3959, in the northwest, is a moderate size spot but has not shown any significant change in recent hours. AR3967 in the southeast now has a very small delta configuration in one of its intermediate spots. All other remaining spot groups are relatively small and have shown only small changes in recent hours.

Although a number of returning regions are expected in the forecast period, far sided helio-seismic soundings do not currently infer the presence of any strong active regions close to the eastern limb. On balance perhaps a slight reduction of forecast flare probabilities during the period, depending on any development of the sunspots currently on the facing-disc, but for now forecast is maintained at current levels.

Overall Moderate activity is forecast, with isolated M-class flares likely and a slight chance of X-class flares.

X-Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 (M Class)	Yes	70	70	70	70
Very Active	R3-R5 (X Class)	No	15	15	15	15

Figure 3: GOES-16 & -18 X-ray flux.



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Solar Radiation Storms (High Energy Protons)

GOES18 high energy proton flux has persisted at Background levels. There is a slight chance of enhancements exceeding the S1 Minor Radiation Storm threshold should any notable flares occur. This includes any activity from AR3964, even as it rotates further around the limb in the coming days, or from AR3961 as it transits across the southwest quadrant.

Radiation Storms Probability (Exceedance)	Level ($cm^{-2}sr^{-1}s^{-1}$)	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	15	15	15	15
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and/or 50 MeV ≥ 10pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

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High Energy Electrons (≥ 2MeV)

High energy electron flux observed at GOES16 has been at mostly Moderate levels, peaking close to the High threshold in the past 24 hours, as a result of the recent extended period of slightly elevated to elevated solar winds. As these winds continue to ease the Radiation Belts are likely to expand outward, with the diurnal peak period at GEO perhaps reaching High levels. However, the longevity of these periods of High flux is currently low confidence due to the lack of any notable geomagnetic activity from these elevated winds, leading to some uncertainty with the extent of any charging. Furthermore, there is a slight chance of a glancing CME arrival early Day 4 (25 Jan), which could help to drop out the observed flux at GEO.

Subsequently, the associated 24 hr fluence has a chance of becoming Active (1e8 integrated pfu) mainly Days 1 to 3 (22-24 Jan), with a likelihood of reducing thereafter. MOSWOC REFM is showing a rising trend but is currently considerably over-predicting fluence levels, so on balance fluence levels are probably more likely to remain below the Active threshold.

GEO Electron Environment	Level ($cm^{-2}sr^{-1}$ day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	≥ 2 MeV ≥ 1×10^{8}	No	30	40	40	30
Very Active	≥ 2 MeV ≥ 1×10^{9}	No	1	1	1	1

Figure 4: GOES-16 Electron flux.

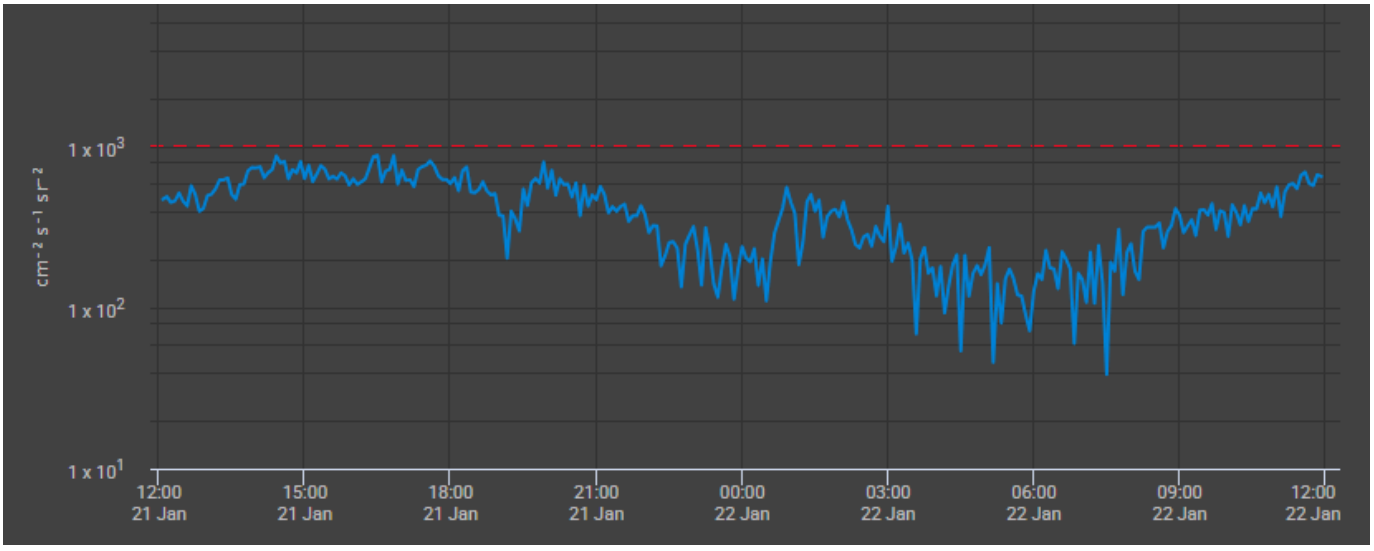

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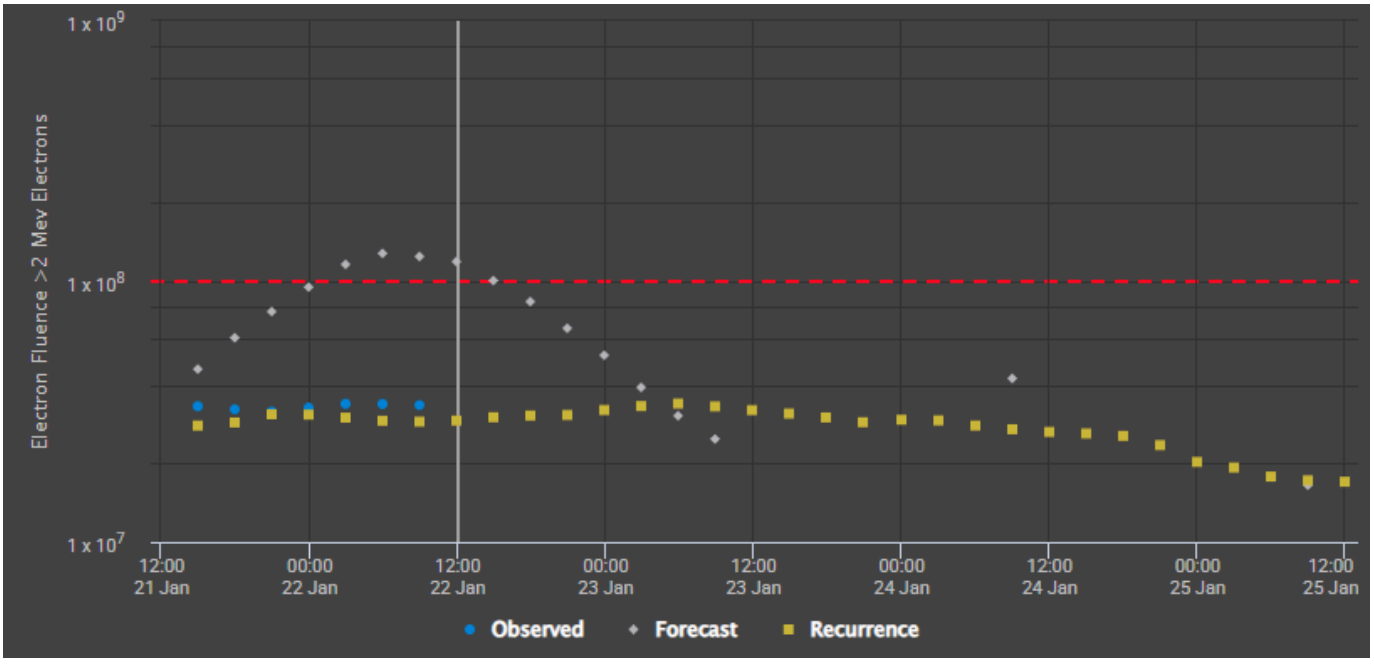
Figure 5: MOSWOC REFM, currently over-predicting the electron fluence.



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